What is claimed is:

1. A reverse blocking semiconductor device comprising:

a drift layer of a first conductivity type;

a MOS gate structure including a base layer of a second conductivity type selectively formed in a front surface region of the drift layer, an emitter region of the first conductivity type selectively formed in a surface region of the base layer, a gate insulation film covering a surface area of the base layer between the emitter region and the drift layer, and a gate electrode formed on the gate insulation film;

an emitter electrode in contact with both the emitter region and the base layer of the MOS gate structure;

an isolation region of the second conductivity type surrounding the MOS gate structure through the drift layer and extending across an entire thickness of the drift layer;

a collector layer of the second conductivity type formed on a rear surface of the drift layer and connecting to a rear side of the isolation region; and

a collector electrode in contact with the collector layer;

wherein a distance W is greater than a thickness d, in which the distance W is a distance from an outermost position of an portion of the emitter electrode, the portion being in contact with the base layer, to an innermost position of the isolation region, and the thickness d is a dimension in a depth direction of the drift layer.

2. The reverse blocking semiconductor device according to claim 1, wherein the thickness of the drift layer has been reduced after the formation of the MOS gate structure.

3. The reverse blocking semiconductor device according to claim 1, wherein lattice defects are introduced at least in the base layer.

4. The reverse blocking semiconductor device according to claim 1, wherein defects are introduced homogeneously to the entire front surface of the semiconductor device to reduce the lifetime of minority carriers in the semiconductor device.

5. A reverse blocking semiconductor device comprising:

a drift layer of a first conductivity type;

a MOS gate structure including a base layer of a second conductivity type selectively formed in a front surface region of the drift layer, an emitter region of the first conductivity type selectively formed in a surface region of the base layer, a gate insulation film covering a surface area of the base layer between the emitter region and the drift layer, and a gate electrode deposited on the gate insulation film;

an emitter electrode in contact with both the emitter region and the base layer of the MOS gate structure;

an isolation region of the second conductivity type surrounding the MOS gate structure through the drift layer and extending across the entire thickness of the drift layer;

a collector layer of the second conductivity type formed on a rear surface of the drift layer and connecting to a rear side of the isolation region;

a collector electrode in contact with the collector layer;

a plurality of field limit layers of the second conductivity type in the front surface region of the drift layer between the emitter electrode and the isolation region, each of the field limit layers having a ring shape; and

a plurality of field limit electrodes, each in contact with each of the field limit layers, each of the field limit electrodes having a ring shape, and being at a floating electric potential; wherein

a plurality of the field limit electrodes exist in the side of the emitter electrode and each of the field limit electrodes in the side of the emitter electrode has a larger outward extension portion than an inward extension portion; and

a plurality of the field limit electrodes exist in the side of the isolation region and each of the field limit electrodes in the side of the isolation region has a larger inward extension portion than an outward extension portion.

6. The reverse blocking semiconductor device according to claim 5, additionally comprising at least one high concentration layer of the first conductivity type in at least a portion of one of the front surface region of the drift layer between the emitter electrode and the isolation region, the high concentration layer containing a higher concentration of impurities than the drift layer.

7. The reverse blocking semiconductor device according to claim 6, wherein a surface concentration of impurities in the high concentration layer is less than 10^{17} cm^{-3}.

8. The reverse blocking semiconductor device according to claim 5, wherein a distance Wg between the adjacent field limit layers is larger than 2 times Wbi, where Wbi is a width of a built-in depletion layer extending from the field limit layer towards the drift layer in a condition in which the emitter electrode and the collector electrode are at an equal electric potential.

9. The reverse blocking semiconductor device according to claim 5, wherein

$W_{G}i > 1.6\ Xj + 2\ Wbi$

in which $W_{G}i$ is a width of an insulator film between (i - 1)-th field limit layer and i-th field limit layer, Xj is a diffusion depth of the field limit layer, and Wbi is a width of a built-in depletion layer extending from the field limit layer towards the drift layer in a condition in which the emitter electrode and the collector electrode are at an equal electric potential.

10. The reverse blocking semiconductor device according to claim 5, wherein a thickness of the drift layer W_{drift} satisfies the inequality in the following formula (2):

$$\sum_{i=1}^{n} L_{Ni} \geq W_{drift} \qquad \text{Formula (2)}$$

wherein

$$L_{Ni} = W_{Gi} - (1.6X_j + 2W_{bi})$$

i is an order number of the field limit layer,

$W_{G}i$ is a width of an insulator film of oxide between (i-1)-th and i-th field limit layer,

n is the total number of the field limit layers.

Xj is a diffusion depth of the field limit layer, and

Wbi is a width of a built-in depletion layer extending from the field limit layer towards the drift layer in a condition in which the emitter electrode and the collector electrode is at an equal electric potential.

11. The reverse blocking semiconductor device according to claim 10, wherein the sum $\Sigma L_{N}i$ and a sum $\Sigma L_{OP}i$ satisfies an inequality $\Sigma L_{OP}i / \Sigma L_{N}i < 0.7$, in which $L_{OP}i$ is a distance between (i-1)-th field limit electrode and i-th field limit layer.

12. The reverse blocking semiconductor device according to claim 5, additionally comprising an intermediate field buffer region of the second conductivity type in a surface region of the drift layer between the plurality of field limit electrodes in the side of the emitter electrode and the plurality of field limit electrodes in the side of the isolation region.

13. A method for manufacturing a reverse blocking semiconductor device comprising:

preparing a substrate of a first conductivity type;

forming a MOS gate structure including processes of selectively forming a base layer of a second conductivity type in a front surface region of the substrate, selectively forming an emitter region of the first conductivity type in a surface region of the base layer, forming a gate insulation film on the surface of the base layer, the surface being between the emitter region and

the front surface of the substrate without the emitter region, and forming a gate electrode on the gate insulation film;

forming an emitter electrode in contact with both the emitter region and the base region of the MOS gate structure;

selectively forming a peripheral region of the second conductivity type surrounding the MOS gate structure through a portion of the substrate outside the MOS gate structure, a part of the peripheral region to become an isolation region;

removing a rear surface region of the substrate to a predetermined thickness to form the isolation region extending across the entire thickness and to form a drift layer of the first conductivity type inside the isolation region;

forming a collector layer of the second conductivity type on a rear surface of the drift layer and connecting to a rear side of the isolation region; and

forming a collector electrode in contact with the collector layer;

wherein a distance W is greater than a thickness d, in which the distance W is a distance from an outermost position of an portion of the emitter electrode, the portion being in contact with the base layer, to an innermost position of the isolation region, and the thickness d is a dimension in a depth direction of the drift layer; and

wherein selectively forming the peripheral region being to become an isolation region is conducted by diffusing impurities using a diffusion mask of an oxide film formed on the front

surface of the substrate, the oxide film having a thickness Xox satisfying an inequality of the following Formula (1):

$$X_{ox} > \sqrt{\frac{D_{ox}}{D_S}} X_S \qquad \text{Formula (1)}$$

wherein

D_{OX} is a diffusion coefficient of the impurity in the oxide film,

D_S is a diffusion coefficient of the impurity in material of the substrate, and

X_S is a diffusion depth of the impurity in material of the substrate.

14. A method for manufacturing a reverse blocking semiconductor device comprising:

preparing a substrate of a first conductivity type;

forming a MOS gate structure including processes of selectively forming a base layer of a second conductivity type in a front surface region of the substrate, selectively forming an emitter region of the first conductivity type in a surface region of the base layer, forming a gate insulation film on the surface of the base layer, the surface being between the emitter region and the front surface of the substrate without the emitter region, and forming a gate electrode on the gate insulation film;

forming an emitter electrode in contact with both the emitter region and the base region of the MOS gate structure;

selectively forming a peripheral region of the second conductivity type surrounding the MOS gate structure through a portion of the substrate outside the MOS gate structure, a part of the peripheral region to become an isolation region;

introducing lattice defects homogeneously to the entire front surface of the semiconductor device to reduce the lifetime of minority carriers in the semiconductor device, the introducing of the lattice defects being conducted by electron beam irradiation with an energy less than 5 MeV and a dose less than 100 kGy;

removing a rear surface region of the substrate to a predetermined thickness to form the isolation region extending across the entire thickness and to form a drift layer of the first conductivity type inside the isolation region;

forming a collector layer of the second conductivity type on a rear surface of the drift layer and connecting to a rear side of the isolation region; and

forming a collector electrode in contact with the collector layer.

15. A method for manufacturing a reverse blocking semiconductor device as claimed in claim 14,

wherein a distance W is greater than a thickness d, in which the distance W is a distance from an outermost position of an portion of the emitter electrode, the portion being in contact with the base layer, to an innermost position of the isolation region, and the thickness d is a dimension in a depth direction of the drift layer; and

wherein selectively forming the peripheral region being to become an isolation region is conducted by diffusing impurities using a diffusion mask of an oxide film formed on the front surface of the substrate, the oxide film having a thickness Xox satisfying an inequality of the following Formula (1):

$$X_{ox} > \sqrt{\frac{D_{ox}}{D_S}} X_S \qquad \text{Formula (1)}$$

wherein

D_{OX} is a diffusion coefficient of the impurity in the oxide film,

D_S is a diffusion coefficient of the impurity in material of the substrate, and

X_S is a diffusion depth of the impurity in material of the substrate.

16. A method for manufacturing a reverse blocking semiconductor device comprising step of:

preparing a substrate of a first conductivity type;

forming a MOS gate structure including processes of selectively forming a base layer of a second conductivity type in a front surface region of the substrate, selectively forming an emitter region of the first conductivity type in a surface region of the base layer, forming a gate insulation film on the surface of the base layer, the surface being between the emitter region and the front surface of the substrate without the emitter region, and forming a gate electrode on the gate insulation film;

forming an emitter electrode in contact with both the emitter region and the base region;

selectively forming a peripheral region of the second conductivity type surrounding the MOS gate structure through a portion of the substrate outside the MOS gate structure, a part of the peripheral region being to become an isolation region;

introducing lattice defects at least in the base layer by electron beam irradiation with a dose in a range of 20 kGy to 60 kGy;

removing a rear surface region of the substrate to a predetermined thickness to form the isolation region extending across whole the thickness and to form a drift layer of the first conductivity type inside the isolation region;

forming a collector layer of the second conductivity type on a rear surface of the drift layer and connecting to a rear side of the isolation region; and

forming a collector electrode in contact with the collector layer.

17. A method for manufacturing a reverse blocking semiconductor device as claimed in claim 16,

wherein a distance W is greater than a thickness d, in which the distance W is a distance from an outermost position of an portion of the emitter electrode, the portion being in contact with the base layer, to an innermost position of the isolation region, and the thickness d is a dimension in a depth direction of the drift layer; and

wherein selectively forming the peripheral region being to become an isolation region is conducted by diffusing impurities using a diffusion mask of an oxide film formed on the front

surface of the substrate, the oxide film having a thickness Xox satisfying an inequality of the following Formula (1):

$$X_{ox} > \sqrt{\frac{D_{ox}}{D_S}} X_S \qquad \text{Formula (1)}$$

wherein

D_{OX} is a diffusion coefficient of the impurity in the oxide film,

D_S is a diffusion coefficient of the impurity in material of the substrate, and

X_S is a diffusion depth of the impurity in material of the substrate.